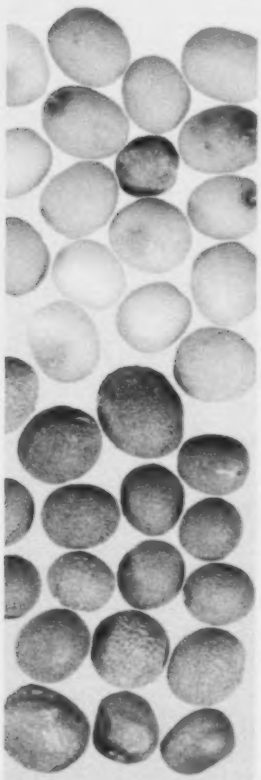

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Quality of western Canadian mustard

2016

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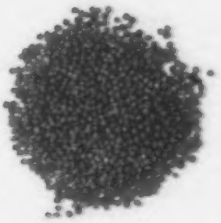
Acknowledgements

The Canadian Grain Commission thanks mustard producers, grain handling offices, and seed handling plants in western Canada for supplying samples of mustard harvested in 2016. The Canadian Grain Commission recognizes its Industry Services grain inspectors for grading samples from the Harvest Sample Program and its Grain Research Laboratory staff for conducting the analyses and preparing the report.

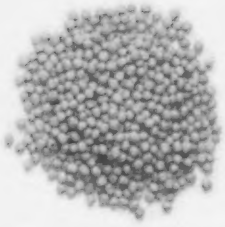
Introduction

This report presents information on the oil, protein and total glucosinolate content, and the fatty acid composition of oriental (*Brassica juncea*), brown (*Brassica juncea*) and yellow (*Sinapis alba*) mustard grown in western Canada in 2016 (Figure 1). The data was obtained from analyses of harvest samples collected by the Canadian Grain Commission.

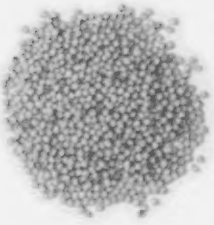
Figure 1 – Mustard crops grown in Canada



Brown mustard; *Brassica juncea*



Yellow mustard; *Sinapis alba*



Oriental mustard; *Brassica juncea*

Summary

Mean fixed oil content for the top grade for oriental and yellow mustard in the 2016 harvest was the same as the 10-year average (42.4 and 30.4%, respectively); while for brown mustard it was lower: brown (37.0% versus 38.5%) (Figures 2, 3 and 4). The mean crude protein for the top grade oriental and yellow mustard was lower than the 10-year average: oriental (25.8 versus 26.1%); yellow (30.5 versus 31.4%) while the brown mustard protein was higher (28.0% versus 27.1%), (Figures 2, 3 and 4). Total glucosinolate content in the top grade mustard was 117 micromoles per gram (μmole/g) for oriental and 106 μmole/g for brown, which was slightly lower than the 10-year average of 121 μmole/g for oriental and 107 μmole/g for brown mustard (Figure 5).

Weather and production review

Weather review

The 2016 growing season for mustard began with a concern about the lack of soil moisture but the early dry spring allowed seeding to begin at the end of April. By the middle of May, nearly 60% of the crop was seeded in Saskatchewan. The crop was developing well in May and June because of timely rains and warmer than average temperatures. In July we had above average precipitation and cooler temperatures giving the promise for above average mustard yields. By the end of July over 90% of the crop was considered either good or excellent in Saskatchewan. Harvesting started in mid-August but rain slowed the harvest so that by the beginning of October just ¾ of the crop was harvested. In the second week of October harvest was stalled because of heavy rains and snow but by mid-November all the crop was off the field. (Saskatchewan Crop Reports - http://www.agriculture.gov.sk.ca/crop-report) and Olds Products 2016 Crop Reports http://www.oldsproducts.com/olds-products/2016-crop-reports).

Temperature and precipitation patterns for the 2016 western Canadian growing season can be found on Agriculture and Agri-Food Canada's web site (http://www.agr.gc.ca/DW-GS/historical-historiques.jspx?lang=eng&jsEnabled=true).

Production and grade information

As shown in Table 1, mustard seed production increased dramatically by approximately 90% from 2015 to 233.9 thousand metric tonnes. The increase was a result of more hectares seeded along with an increase in yield. Yield was approximately 1160 kilograms per hectare (Statistics Canada), which is higher than last year's yield of 930 kilograms per hectare and the 10-year average of 928 kilograms per hectare.

About 55% of mustard production in Saskatchewan was estimated to be yellow, 14% brown and 31% oriental according to Saskatchewan's 2016 Specialty Crop Report (http://publications.gov.sk.ca/documents/20/97099-Specialty%20Crop%20Report%202016%20WEB.pdf). Saskatchewan accounted for 74% of western Canada's total seeded area and nearly 69% of mustard production while Alberta accounted for most of the remaining seeded area and production (Table 1).

This year 52% of samples were graded No. 1, in contrast to 58% in 2015 and 72% for the 10-year average (2006-15). Growing and harvest conditions produced a mustard crop with some visible damage especially in Oriental. In Yellow mustard, however, conspicuous admixtures from weed seeds and foreign material were major factors in lowering the grades of samples received in 2016.

Table 1 – Seeded area and production for western Canadian mustard[1]

Region	Seeded area 2016	Seeded area 2015	Production 2016	Production 2015	Mean production 2006-15
	thousand hectares		thousand tonnes		thousand tonnes
Manitoba	n/a[2]	n/a	n/a	n/a	n/a
Saskatchewan	157.8	103.2	162.3	91.5	113.0
Alberta	54.5	36.4	71.6	31.9	37.9
Western Canada	**212.3**	**139.6**	**233.9**	**123.4**	**150.9**

[1] Statistics Canada. Table 001-0010 - Estimated areas, yield, and production of principal field crops, in metric units. http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=0010010&paSer=&pattern=&stByVal=1&p1=1&p2=-1&tabMode=dataTable&csid)

[2] Data for Manitoba not available.

Harvest samples

This year's Harvest Sample Program included 344 samples, compared to 367 in 2015. This included 197 yellow, 46 brown and 101oriental mustard samples. Overall, 71% of the samples came from Saskatchewan, followed by 26% from Alberta and 3% from Manitoba.

Producers and grain companies that routinely handle mustard seed submitted samples of mustard grown in 2016 to the Canadian Grain Commission. The individual samples were cleaned to remove dockage and were graded by Canadian Grain Commission inspectors, following Chapter 12 of the Official Grain Grading Guide. (https://www.grainscanada.gc.ca/oggg-gocg/ggg-gcg-eng.htm)

Oil and protein content on all individual whole-seed samples were determined by using a FOSS NIRSystems 6500 NIR spectrometer, calibrated to and verified against the appropriate listed reference methods. Total glucosinolate content was also determined on individual brown and oriental mustard samples. The reference procedures are listed under Oilseeds Methods http://www.grainscanada.gc.ca/oilseeds-oleagineux/method-methode/omtm-mmao-eng.htm.

Composite samples were analysed for oil, protein, total glucosinolate and chlorophyll content, as well as for fatty acid composition. Composites were prepared by combining No. 1 mustard samples by province and type and by combining No. 2, No. 3, No. 4 and Sample grades by western Canada and by type. Composites were also prepared for the most common mustard varieties.

Effects of weather on quality

The mustard crop grown in western Canada in 2016 showed general characteristics of a crop well matured. The Grain Research Laboratory's long-term Harvest Sample Program results show that cool and moist growing conditions tend to produce an oilseed crop with lower protein content, this trend is especially noticed in yellow mustard. Research also shows that total glucosinolate levels may decrease when *Brassica* crops are grown under cooler than normal conditions.

Quality of Domestic Mustard Seed: Oriental and Brown

Oil, protein and total glucosinolate content for oriental and brown mustard is summarized by grade in Table 2. Comparisons to previous years' data are in Figures 2, 3 and 5.

Mean fixed oil content (42.4%) in Oriental Mustard, No. 1 Canada was lower than the mean in 2015 (43.4%) (Figure 2). Meanwhile, mean crude protein content (25.8%) was higher than the 2015 mean (25.3%) (Figure 2). Fixed oil content in samples of Oriental Mustard, No. 1 Canada from producers ranged from 36.9 to 47.4%, whereas protein content ranged from 22.3 to 31.2% (Table 2).

Mean fixed oil content (37.0%) in Brown Mustard, No. 1 Canada was slightly lower than the mean in 2015 (37.4%). Meanwhile, mean crude protein content (28.0%) was slightly higher than the 2015 mean (27.7%) (Figure 3). Fixed oil content in samples of Brown Mustard, No. 1 Canada from producers ranged from 34.5 to 40.5% while the protein content ranged from 25.1 to 31.2% (Table 2).

Total glucosinolate content in Oriental Mustard, No.1 Canada was 117 μmole/g, a value lower than in 2015 at 127 μmole/g (Figure 5). The value for Brown Mustard, No.1 Canada was also lower than the value for 2015, 106 versus 112 μmole/g (Figure 5). Total glucosinolate content in samples of Oriental Mustard, No. 1 Canada from producers ranged from 56 to 145 μmole/g. Total glucosinolate content in samples of Brown Mustard, No. 1 Canada from producers ranged from 89 to 114 μmole/g (Table 2).

Fatty acid composition of oriental and brown mustard composites is provided in Table 3. Erucic acid (C22:1) levels for Oriental Mustard, No.1 Canada (21.9%) and Brown Mustard, No.1 Canada (23.8%) were similar to the 2015 values of 22.3% and 23.6% respectively (https://www.grainscanada.gc.ca/mustard-moutarde/harvest-recolte/2015/hqm15-qrm15-1-en.htm). These values for oriental and brown mustard are typical of *Brassica juncea* condiment mustards.

Total saturated fatty acids for Oriental and Brown Mustard, No.1 Canada composites were 6.0 and 5.9%, respectively, which was similar to last year's values for both types at 6.0%. There were only small changes in the levels of oleic, linoleic and linolenic acid. As a result, the iodine value (an indicator of oil unsaturation) was similar to 2015 values for both oriental and brown mustard at 119 and 120 units, respectively.

Chlorophyll content of oriental and brown mustard composites is provided in Table 4. Chlorophyll content was 2.9 and 6.5 mg/kg for Oriental and Brown Mustard, No. 1 Canada, respectively (Figure 6) which is significantly higher than the 7-year average of 1.9 and 3.4 mg/kg. The lower grades in both types had higher levels of chlorophyll, ranging from 2.4 to 16.8 mg/kg.

Quality of Domestic Mustard Seed: Yellow

Oil and protein content for yellow mustard is summarized by grade in Table 2. Comparisons to previous years' data are in Figures 4 and 6.

Yellow mustard has characteristically lower oil content and higher protein content than oriental and brown mustard (Table 2). Mean fixed oil content (30.4%) in Yellow Mustard, No. 1 Canada was higher than the mean in 2015 (29.5%). Meanwhile, mean crude protein content (30.5%) was lower than the 2015 mean (32.3%) (Figure 4). Fixed oil content in samples of Yellow Mustard, No. 1 Canada from producers ranged from 25.9 to 34.4% while crude protein ranged from 26.3 to 37.6%.

Fatty acid composition for yellow mustard composites is provided in Table 3. The fixed oil in yellow mustard contained higher amounts of oleic (C18:1) and erucic acid (C22:1) but lower amounts of linoleic (C18:2) and linolenic acid (C18:3), compared to the oil in oriental and brown mustard. Mean erucic acid content in Yellow Mustard, No.1 Canada was 33.9%, compared to 34.8% in 2015. Total saturated fatty acids (5.2%) and iodine values (102 units) were similar to the 2015 values.

Chlorophyll content of yellow mustard composites is provided in Table 4. Chlorophyll content in Yellow Mustard, No. 1 Canada was 1.2 mg/kg (Figure 6), which corresponds to the low distinctly green seed count (%DGR). The lower grades had slightly increased levels of chlorophyll, as high as 3.1 mg/kg for Sample grade. Chlorophyll content for No. 1 Canada was slightly higher than the 7-year mean of 0.8 mg/kg.

Table 2 – Quality of 2016 western Canadian mustard

Grade	No. of samples	Oil content %[1]			Protein content %[2]			Glucosinolate content µmole/g[3]		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Domestic Mustard Seed, Canada, Oriental										
No. 1 - W. Canada	**45**	**42.4**	**36.9**	**47.4**	**25.8**	**22.3**	**31.2**	**117**	**56**	**145**
Saskatchewan	40	42.3	36.9	47.4	26.0	22.3	31.2	118	56	145
Alberta	5	43.9	38.9	46.2	24.8	22.6	28.1	111	83	125
No. 2	31	41.7	37.0	46.1	26.4	22.2	31.4	121	104	140
No. 3	15	40.2	36.2	44.5	27.9	23.5	30.8	124	109	147
No. 4	4	39.6	38.8	41.6	28.0	26.9	29.3	130	124	143
Sample	6	41.5	39.1	44.6	25.5	24.1	27.9	113	98	121
Cutlass, No.1	20	42.7	37.4	47.3	26.0	22.3	31.2	115	56	130
Forge, No. 1	19	41.3	36.9	44.3	25.8	22.9	30.0	126	108	145
Domestic Mustard Seed, Canada, Brown										
No. 1 - W. Canada	**34**	**37.0**	**34.5**	**40.5**	**28.0**	**25.1**	**31.2**	**106**	**89**	**114**
Saskatchewan	33	37.0	34.5	40.5	27.9	25.1	31.2	106	89	114
Alberta	1	35.7	-	-	28.7	-	-	105	-	-
No. 2	5	37.5	35.0	40.7	27.6	23.9	31.9	100	93	102
No. 3	1	34.5	-	-	27.5	-	-	93	-	-
No. 4	3	38.1	35.6	41.8	27.0	24.2	29.4	89	66	114
Sample	3	35.6	35.3	38.8	26.3	23.8	28.1	110	91	141
Centennial Br., No. 1	20	37.3	35.2	39.8	27.7	25.7	31.2	105	89	109
Domestic Mustard Seed, Canada, Yellow										
No. 1 - W. Canada	**98**	**30.4**	**25.9**	**34.5**	**30.5**	**26.3**	**37.6**	—		
Manitoba	3	28.3	25.9	31.5	33.1	31.2	37.6	—		
Saskatchewan	46	30.2	26.2	34.5	30.6	26.3	36.5	—		
Alberta	49	30.7	26.9	34.2	30.4	26.7	37.6	—		
No. 2	33	29.7	23.6	34.4	31.7	26.8	39.1	—		
No. 3	21	30.2	26.5	33.8	30.5	27.4	35.2	—		
No. 4	27	30.3	25.5	33.7	31.2	27.3	36.8	—		
Sample	18	28.9	24.5	33.2	31.2	24.1	36.3	—		
AC Pennant, No. 1	5	31.4	29.3	34.1	29.9	26.7	33.3	—		
Andante, No. 1	75	30.7	25.9	34.5	30.6	26.3	37.6	—		

[1] Dry matter basis

[2] % N x 6.25; dry matter basis

[3] Total glucosinolates (µmole/g); dry matter basis - ISO 9167-3:2007 (Glucose Release).

Table 3 – Fatty acid composition of 2016 western Canadian mustard

Category	No. of samples	Fatty acid composition (%)[1] C18:0	C18:1	C18:2	C18:3	C22:1	Saturated fatty acids[2]	Iodine value
Domestic Mustard Seed, Canada, Oriental								
No. 1 - W. Canada	**45**	**1.5**	**21.7**	**22.0**	**12.7**	**21.9**	**6.0**	**119**
Saskatchewan	40	1.5	21.9	22.1	12.7	21.7	6.0	119
Alberta	5	1.5	20.4	21.1	12.9	23.2	5.8	118
No. 2	31	1.5	20.3	21.6	13.0	23.1	5.8	119
No. 3	15	1.4	18.8	21.8	13.3	24.0	5.9	120
No. 4	4	1.4	20.6	21.7	13.1	22.8	5.8	119
Sample	6	1.5	22.2	22.3	12.8	21.3	6.2	119
Cutlass, No.1	20	1.4	20.2	21.0	13.0	23.7	5.8	118
Forge, No. 1	19	1.6	23.9	23.3	12.2	19.4	6.1	119
Domestic Mustard Seed, Canada, Brown								
No. 1 - W. Canada	**34**	**1.2**	**18.5**	**20.8**	**14.2**	**23.8**	**5.9**	**120**
Saskatchewan	33	1.2	18.5	20.8	14.2	23.8	5.9	120
Alberta	1	1.3	16.6	21.8	14.6	24.3	6.1	122
No. 2	5	1.3	18.6	20.5	14.4	23.7	5.9	120
No. 3	1	1.3	16.8	21.9	14.7	23.9	6.2	122
No. 4	3	1.4	18.6	21.6	14.2	23.2	6.1	121
Sample	3	1.4	21.4	21.1	14.1	20.7	6.2	120
Centennial Br., No.1	20	1.2	18.5	20.8	14.2	23.7	5.9	120
Domestic Mustard Seed, Canada, Yellow								
No. 1 - W. Canada	**98**	**1.1**	**26.8**	**9.0**	**10.4**	**33.9**	**5.2**	**102**
Manitoba	3	1.1	26.4	9.1	10.4	34.3	5.1	102
Saskatchewan	46	1.1	27.1	9.3	10.2	33.4	5.2	102
Alberta	49	1.1	26.5	8.8	10.5	34.3	5.2	102
No. 2	33	1.1	26.0	9.1	10.6	34.4	5.1	102
No. 3	21	1.1	26.2	9.0	10.5	34.4	5.2	102
No. 4	27	1.1	26.1	9.3	10.7	34.2	5.2	102
Sample	18	1.1	26.0	9.6	10.8	33.8	5.3	103
AC Pennant, No. 1	5	1.1	26.1	8.9	9.8	35.6	5.1	100
Andante, No. 1	75	1.1	26.9	9.0	10.4	33.7	5.2	102

[1] Percentage of total fatty acids including: stearic (C18:0), oleic (C18:1), linoleic (C18:2), linolenic (C18:3), erucic (C22:1)

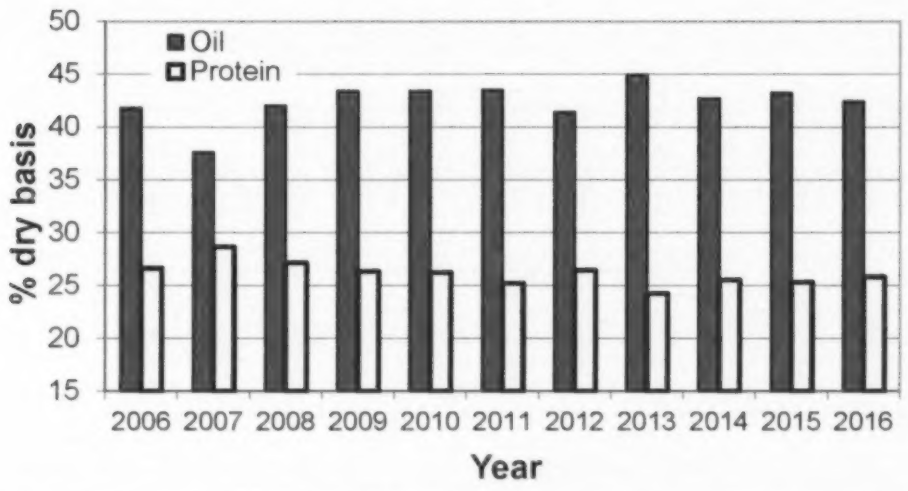
[2] Saturated fatty acids are defined as the sum of C16:0, C18:0, C20:0, C22:0, and C24:0.

Table 4 – Chlorophyll Content and DGR in 2016 western Canadian mustard

Category	No. of samples	Chlorophyll mg/kg	Distinctly green (%DGR)[1]	%DGR range
Domestic Mustard Seed, Canada, Oriental				
No. 1 - W. Canada	**45**	**2.9**	**0.28**	**0.0-1.2**
Saskatchewan	40	3.0	0.28	0.0-1.2
Alberta	5	2.2	0.28	0.0-1.0
No. 2	31	5.2	0.54	0.0-1.5
No. 3	15	10.1	1.71	0.0-2.6
No. 4	4	2.4	0.00	0.0
Sample	6	13.3	2.90	0.0-8.0
Cutlass, No. 1	20	3.6		
Forge, No. 1	19	2.8		
Domestic Mustard Seed, Canada, Brown				
No. 1 - W. Canada	**34**	**6.5**	**0.14**	**0.0-0.8**
Saskatchewan	33	6.7	0.14	0.0-0.8
Alberta	1	2.0	0.40	-
No. 2	5	7.0	0.72	0.0-2.0
No. 3	1	16.8	1.00	-
No. 4	3	8.2	0.33	0.0-1.0
Sample	3	13.6	0.40	0.0-1.2
Centennial Br., No. 1	20	5.7		
Domestic Mustard Seed, Canada, Yellow				
No. 1 - W. Canada	**98**	**1.2**	**0.03**	**0.0-0.6**
Manitoba	3	1.8	0.07	0.0-0.2
Saskatchewan	46	0.9	0.04	0.0-0.6
Alberta	49	1.5	0.01	0.0-0.4
No. 2	33	1.4	0.15	0.0-1.0
No. 3	21	1.1	0.08	0.0-1.6
No. 4	27	2.0	0.03	0.0-0.4
Sample	18	3.1	0.00	0.0
AC Pennant, No. 1	5	0.4		
Andante, No. 1	75	1.4		

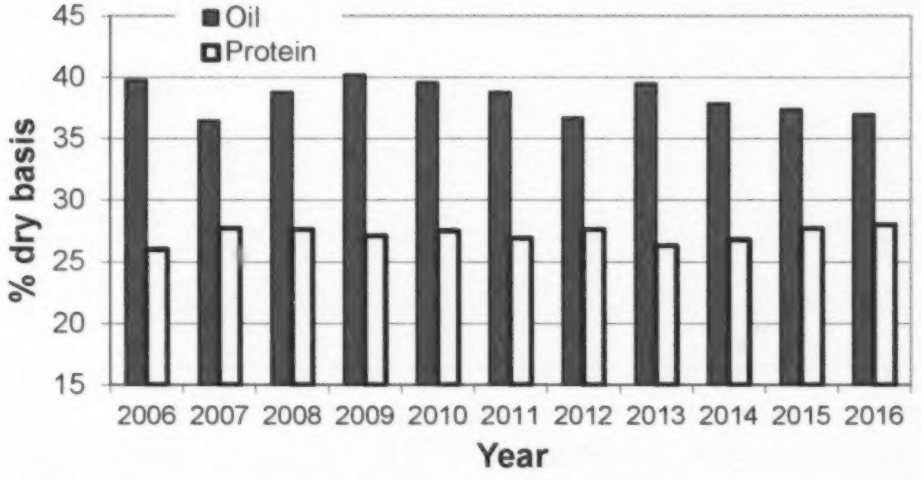
[1] Distinctly green tolerance is applied to crushed seeds which are a distinct green throughout. Pale green or immature seeds are taken into account in the evaluation of colour. The %DGR results are the averages of the individual samples included in the composite.

Figure 2 – Oriental Mustard, No.1 Canada
Oil and protein content of harvest samples, 2006-16



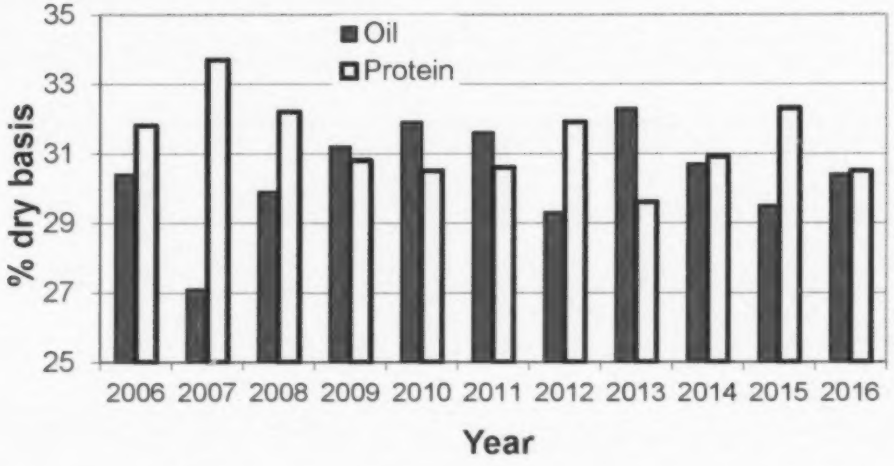
2016 Oil content.....42.4%	2016 Protein content 25.8%
2015 Oil content 43.2%	2015 Protein content 25.3%
2006–15 Mean oil content.....42.4%	2006–15 Mean protein content.....26.1%

Figure 3 – Brown Mustard, No.1 Canada
Oil and protein content of harvest samples, 2006-16



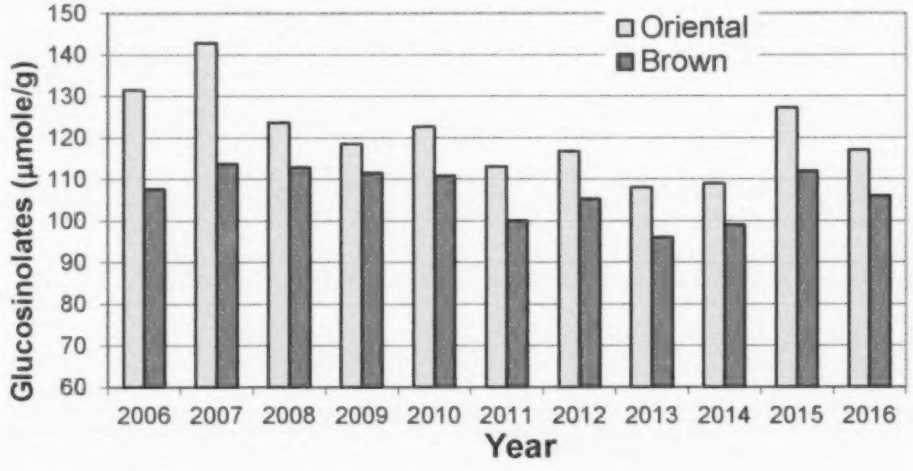
2016 Oil content.....37.0%	2016 Protein content 28.0%
2015 Oil content 37.4%	2015 Protein content 27.7%
2006–15 Mean oil content.....38.5%	2006–15 Mean protein content.....27.1%

Figure 4 – Yellow Mustard, No.1 Canada
Oil and protein content of harvest samples, 2006-16



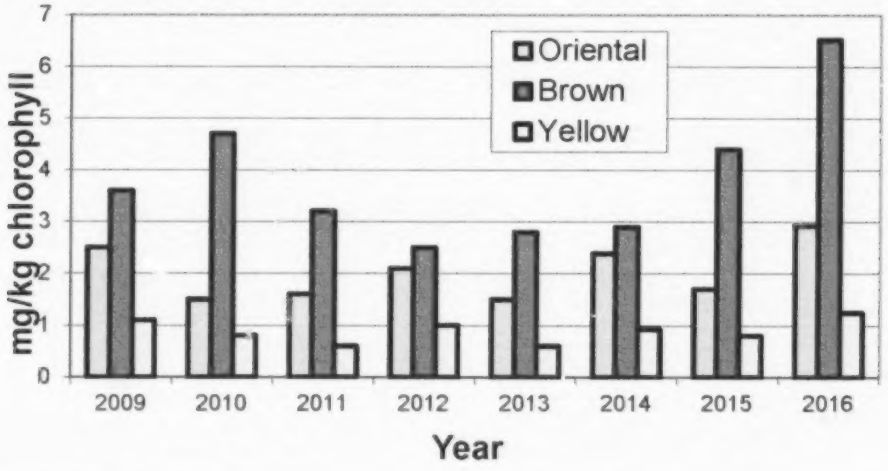
2016 Oil content.....30.4%	2016 Protein content 30.5%
2015 Oil content 29.5%	2015 Protein content 32.3%
2006–15 Mean oil content.....30.4%	2006–15 Mean protein content.....31.4%

Figure 5 – Oriental and Brown Mustard, No.1 Canada
Total glucosinolate content of harvest samples, 2006-16



2016 Oriental glucosinolate content.....117 µmole/g	2016 Brown glucosinolate content.....106 µmole/g
2015 Oriental glucosinolate content.....127 µmole/g	2015 Brown glucosinolate content.....112 µmole/g
2006–15 Mean Oriental Glucosinolate content.....121 µmole/g	2006–15 Mean Brown glucosinolate content.....107 µmole/g

Figure 6 – Oriental, Brown and Yellow Mustard, No.1 Canada
Chlorophyll content of harvest samples, 2009-16



2016 Oriental chlorophyll content	2.9 mg/kg
2016 Brown chlorophyll content	6.5 mg/kg
2016 Yellow chlorophyll content	1.2 mg/kg
2009–15 Mean Oriental chlorophyll content	1.9 mg/kg
2009–15 Mean Brown chlorophyll content	3.4 mg/kg
2009–15 Mean Yellow chlorophyll content	0.8 mg/kg